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EXPERIMENTS WITH EGYPTIAN COTTON IN 1908.

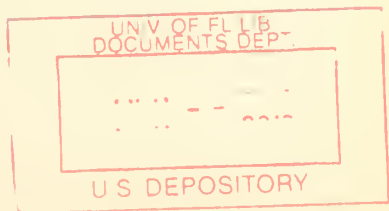
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AND—EGYPTIAN COTTON CULTIVATION IN THE UNITED STATES



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EXPERIMENTS WITH EGYPTIAN COTTON IN 1908.

INTRODUCTION.

In 1908 about 40 acres of land were planted to Egyptian cotton in the Colorado River region. A few small plantings to test the effect of diverse climatic and soil conditions were made in the Imperial and Coachella valleys, California, but the greater part of this acreage was located in the valleys of the Gila, Salt, and Colorado rivers, in Arizona. The largest planting—19 acres—was made on the Pima Indian Reservation, at Sacoan, Ariz., by the Office of Plant Life History Investigations of the Bureau of Plant Industry, in co-operation with the Indian Office of the Department of the Interior. Five acres were grown at Yuma, Ariz., on the experimental farm operated by the Office of Western Agricultural Extension in co-operation with the Reclamation Service; 2 acres on the Indian school farm at Phoenix, and the rest was put in by individual farmers, chiefly in the Gila Valley, west of Phoenix.

The plantings were so distributed as to place the cotton, which had been grown during the two previous seasons only at Yuma, under a considerable variety of conditions as to climate, soil, and irrigation. Consequently, it was possible to obtain some idea of the degree of diversity to be expected as the result of transfer from one locality to another. During the summer it became apparent that the plants were behaving differently in different places. Arrangements were

The results of the experiments with Egyptian cotton in the Southwestern States up to the end of the year 1907 were stated in Bulletin No. 128 of the Bureau of Plant Industry, entitled "Egyptian Cotton in the Southwestern United States," by Thomas H. Kearney and William A. Peterson, which also discussed the cotton industry in Egypt, describing briefly the climate and soil and the methods used in growing the crop and handling the product. The principal Egyptian varieties were described and statistics were given concerning Egyptian cotton as an import into the United States. The present circular gives an account of the progress of the work since the publication of Bulletin No. 128. B. W. CAMPBELL, *Physiologist and pathologist, U. S. Bureau of Plant Industry.*

therefore made for Mr. O. F. Cook, of the Bureau of Plant Industry, and two of his assistants, Messrs. Argyle McLachlan and Roland Meade, to spend several weeks at Yuma and Sacaton in the early autumn, studying the variations of this cotton in process of acclimatization. They had become familiar with similar phenomena in the course of their investigation of the behavior of Central American varieties of cotton when introduced into the United States. Incidentally they made a careful study of the hybrids with Upland cottons that were present in the acclimatized stock of the Egyptian type.

The services of Mr. John A. Walker, an expert classifier of Egyptian cotton, were secured in order that the fiber produced might be properly graded as it came from the gins. Mr. Walker distinguished six grades in the cotton produced at Sacaton and Yuma, basing the grades upon freedom from trash, upon length, strength, and fineness of the staple, and upon color and uniformity. In baling, the different grades were kept separate and great care was taken to have the contents of each bale as uniform as possible. In all, about 12 bales were obtained, which it is proposed to market under such circumstances as will give a fair idea of the profits to be expected from this type of cotton in the Colorado River region.

While the results of the experiments in 1908 were in the main favorable, further experimental work will be necessary before the seed can safely be distributed to farmers. Considerable diversity in the growth of the plants and the quality of the fiber appeared at the different localities where experiments were made, indicating a need of adjustment to local differences of soil and climate inside the region in which this strain of cotton has already become acclimatized in a general way. Much of the fiber was shorter and less uniform, especially in length and color, than could be desired, showing that the plant-breeding work must be carried farther before a stock of seed suitable for placing in the hands of farmers is secured. It is also highly important that we know more about how to irrigate Egyptian cotton before definite advice on this subject is offered. Experience has shown that the form and size of the plant (upon which the yield largely depends) and the quality of the fiber are very sensitive to differences in frequency and times of irrigation, but more precise knowledge on this point is needed.

The following discussion of the results of last year's experiments is prefaced by a statement regarding the volume and value of the imports of Egyptian cotton into the United States in 1908 and by a report on spinning tests made by manufacturers with the fiber produced at Yuma in 1907.

IMPORTS AND PRICES OF EGYPTIAN COTTON IN 1908.

In order to justify the continuance of experiments looking to a possible establishment of Egyptian cotton culture in the Southwest, where the cost of labor and transportation are exceptionally high, it must be shown that there is a continued heavy demand for this type of cotton and that the prices paid for it are sufficiently high to afford reasonable expectation of good profits from growing it. Furthermore, it must be shown that Egyptian cotton commands a considerable premium in the market over ordinary American Upland cotton if the former type is to be given the preference by southwestern farmers interested in cotton culture.

In a preceding publication^b statistics were given of the total imports of Egyptian cotton into the United States during the ten years from 1898 to 1907, inclusive, and of the average prices of Egyptian and Middling Upland cottons on the Boston and Liverpool markets during the same period.

During 1908, 61,511,723 pounds of cotton, valued at \$11,560,009, were imported into the United States direct from Egypt, and 6,953,412 pounds, valued at \$1,067,287, the great bulk of which was doubtless Egyptian cotton, were imported by way of the United Kingdom. The direct imports of Egyptian cotton in 1908 were about 8,000,000 pounds heavier than the average for the preceding ten years, although about 17,000,000 pounds lighter than in 1907. The comparative dullness of the cotton market last year is doubtless chiefly responsible for this decline in the import.

The average price paid on the Boston market for all grades of Egyptian cotton imported during 1908 was 18.07 cents, as compared with 11.11 cents for Middling Upland. The average prices of Egyptian and Middling Upland cottons on the same market during the ten years from 1898 to 1907, inclusive, were 15.3 cents and 9.5 cents, respectively, while in 1907 the average prices were 21.9 cents for Egyptian and 11.8 cents for Middling Upland. There was a general fall in the prices of both classes of cotton during the year 1908, and in February, 1909, the price of Egyptian had reached an average of 15.09 cents and that of Middling Upland 10.25 cents on the Boston market. It will be noted, however, that the premium over Middling Upland commanded by Egyptian cotton, which ranged from 4 to 10 cents during the years 1897 to 1908, was still about 5

^aThe figures here given were furnished by the Chief of the Bureau of Statistics, United States Department of Agriculture.

^bBulletin No. 128 of the Bureau of Plant Industry, entitled "Egyptian Cotton in the Southwestern United States," p. 25, Tables 1 and 5.

^cThere is a well-known tendency in the cotton market to lower the premium paid for high-class cottons when the price of Uplands is declining.

cents in February, 1909. It should also be noted that the prices of Egyptian cotton quoted are those of the average and not of the best grades of the Mit Afifi variety imported into the United States, the latter ranging from 2 to 3 cents higher, while the Jannovitch variety brings from 4 to 6 cents more than the average for Mit Afifi. If cotton of the Egyptian type is to be grown in the Southwest the production of a quality comparable in value with the highest imported grades is the goal to be kept steadily in view.

The crop of 1908 in Egypt is estimated to amount to between 625,000,000 and 650,000,000 pounds, or nearly 100,000,000 pounds less than that of 1907. The smaller yield is attributed chiefly to unusually low temperatures and excessive atmospheric humidity during the early autumn.

SPINNING TESTS OF 1907 FIBER.

Small samples of the Egyptian cotton grown at Yuma in 1907 were sent to a considerable number of manufacturers in order to obtain their opinion of its quality and value. The results of their examination are summarized in Bulletin No. 128 of the Bureau of Plant Industry, pages 44-45. In order to test this cotton more thoroughly, samples of 200 pounds each were sent to three of the American mills which manufacture large quantities of imported Egyptian cotton, with a request that spinning tests be made. It will be interesting to quote in detail from the reports on these tests, which have recently been completed:

The first mill reported as follows:

Upon receipt of the sample of Arizona cotton we immediately put it in process of manufacturing and find it a very satisfactory cotton in every way; and in all of the various operations we produced about 28 per cent of waste, this being very close to what we take out in our regular Egyptian cotton.

The cotton spins well up to 110s filling. The 64s warp yarn sizes 63.30, breaks at $33\frac{1}{2}$ pounds, with 33.7 turns twist per inch. This is the same twist that we use in spinning Peeler cotton. Our regular Egyptian cotton sizes 61.10, breaks at $28\frac{1}{2}$ pounds, having 37 turns twist. Peeler cotton sizes 64.45, breaks at 35 pounds, with 33.7 turns per inch twist. What we refer to as 104s filling really sizes 102.7, breaks at 13 pounds, with 27.37 turns twist per inch. 104s filling made of Peeler cotton actually sizes 104s, breaks at $13\frac{1}{2}$ pounds, same number of turns twist as the above.

The cotton runs full $1\frac{1}{2}$ inches staple, maybe nearer $1\frac{7}{8}$ inches, and according to our superintendent is good for warp yarn running from 65s to 70s and filling yarn up to 100s to 104s. The spinning qualities are very similar to those possessed by Peeler cotton. The waste is not excessive. In general appearance it is very close to Egyptian, but, we think, lacks a little of the smooth and silky feel.

This mill furnished a very interesting series of samples of roving, yarn, and sliver from the Arizona-grown cotton, and of sateen and

plain cloth in which either Peeler or Sea Island fiber was used for the warp and the Arizona cotton for the filling.

From the second mill the following report was received:

You will note that for No. 50s yarn the Arizona cotton is better than the Brown Egyptian which we use for that number, but when we come to spin No. 80s you will note that it is not as good as Jannovitch, second quality. Again, when we come to spin No. 100s, you will notice that in the single yarn the breaking strength of the Arizona is 18.40, against 18.92 for our Jannovitch, first quality; whereas in the Gray Thread the breaking strength of Arizona is 19.9, and Jannovitch, first quality, 21.3. Taking the cotton as a whole, we class it much better than the regular Brown Egyptian, but not as good as Jannovitch, although this cotton might do very well for cloth mills for fine numbers up to, say, 110s. The waste is practically the same as Jannovitch.

The third mill furnished the following statement:

We have tested the Arizona-grown seed cotton, and beg to report that we find the cotton lighter in color than the average Brown Egyptian. The staple has a slightly harsh, rough feel, is very lofty, and does not lie down in the processes as the average Mit Afifi Egyptian. The staple runs from 1 $\frac{1}{2}$ to 1 $\frac{3}{4}$ inches. Owing to its length we have found it necessary to put it through machinery under full Sea Island setting, in consequence making more waste than should be had there been quantity enough of the cotton to make it practicable to adjust the machinery to its best needs. The yarns are smooth, even, and elastic, and the break of the average No. 22.44 is 135 pounds at humidity of 55 per cent. This is 19 pounds stronger than a good Mit Afifi cotton and about 2 pounds weaker than a good Georgia-grown Sea Island. We are very much pleased and impressed with the cotton, and could it be grown in quantity and in quality equal to sample it would be valuable for our class of products.

If we sum up the opinions of these three firms, we find them to be decidedly favorable as regards the quality of the Arizona-grown cotton. It is therefore no longer a question whether a good grade of cotton of this type can be produced in the Southwestern States. The problem that remains to be worked out is whether the economic conditions of the region will justify farmers in undertaking the growing of any kind of cotton.

RESULTS OF EXPERIMENTS IN 1908.

EXPERIMENTAL FIELDS AT YUMA AND SACATON, ARIZ.

At Yuma about 5 acres of sandy loam soil, the same land used for the experiments in 1907, was planted to Egyptian cotton in 1908. The land was divided into a number of small plots, ranging in size from 1 acre to less than one-tenth acre, which were used for the plant-breeding nursery and for tests of the yield and quality of fiber from various lots of the acclimatized seed. Experiments were also made to test different distances of planting, different times of planting,

and the behavior of newly imported seed of the Mit Afifi and Jannovitch varieties as compared with the acclimatized stock.

The entire field was flooded on February 26. Most of the plots were planted from March 10 to 13, and thinned from April 11 to 15, and again from May 15 to 21. Most of them received five irrigations after the seed was put in, but some were watered only three or four times. From three to six cultivations were given on the different plots. The number and dates of the pickings differed widely. The two plots which yielded at the heaviest rate per acre were picked four times, the first picking having been made September 24-25 and the last picking December 18-19.

At Sacaton,^a on the south bank of the Gila River, about 30 miles southeast of Phoenix, the cotton was planted on a sandy loam soil in two fields about one-half mile apart. One field was planted March 24-30 and the other April 3-4. The first field was nearly new land, which had borne previously only two crops of grain, while the second was an old alfalfa field. The preparation was alike in both, the land having been plowed, harrowed, irrigated, disked, and harrowed before planting. The preliminary irrigation was by flooding—one field March 17-18 and the other March 24-26. Subsequent irrigations were by furrows, except the second irrigation on a section of the first field, which was by flooding. The cotton was planted in rows 5 feet apart, the hills $2\frac{1}{2}$ feet apart in the rows. The different sections of the two fields were irrigated from three to five times after planting.

During the months from April to November the total rainfall at Sacaton was 6.39 inches, of which 2.16 inches fell in July and 2.31 inches in September.

COMPARISON OF IMPORTED AND ACCLIMATIZED SEED.

In a previous publication^b attention was called to the poor performance of Egyptian cotton when first grown in the Southwestern States as compared with the results after several years of acclimatization. In 1908 seed of the Mit Afifi and Jannovitch varieties obtained directly from Egypt was planted alongside the acclimatized stock, which was derived originally from the Mit Afifi variety, but which had been grown for six years in the Southwest. This experiment furnished additional evidence of the importance of acclimatiza-

^a Mr. E. W. Hudson, superintendent of the farm on the Pima Indian Reservation, managed by the Office of Plant Life History Investigations in co-operation with the Indian Office of the Department of the Interior, had immediate charge of the work at Sacaton. The data here given are taken from his detailed report on the season's work.

^b Bulletin No. 128, Bureau of Plant Industry, pp. 38-39.

tion, the newly imported seed giving decidedly inferior results as regards both yield and quality of the fiber.

DIFFERENT BEHAVIOR OF THE DIFFERENT PLANTINGS.

Considerable diversity in the shape and productiveness of the plants, as well as in the quality of the fiber, was manifested in the different localities where the cotton was grown in 1908, although the same general stock of acclimatized seed was everywhere used. This diversity was doubtless partly due to the widely different dates of planting (March 10 to June 1), to the different preparation of the land, and to different methods of irrigation and tillage practiced in the various localities. Part of it, however, is probably attributable to differences in climate and soil.

A particularly striking case was a small planting made at Coachella, near Indio, Cal. All the plants in this one-tenth-acre plot, though grown from the acclimatized stock of seed produced at Yuma in 1907, made an erect, spindling growth with few branches, similar to that of plants grown at Yuma from one of the lots of newly imported seed. Individual variation was suppressed to a remarkable degree, all the plants resembling each other much more closely than in any other locality. This seed was planted late (April 27), yet not nearly so late as at other localities, where the usual amount of diversity appeared and where the shape of the plants was very different. Nor could it be learned that the treatment of the plot with respect to irrigation and other cultural details was in any way exceptional.

Such behavior indicates that special precautions to secure local adjustment may be required in each of the principal irrigated valleys where Egyptian cotton is to be grown, in addition to the general adaptation to the region secured by six years of acclimatization and selection in the Southwest.

YIELDS.

A total of about 6,000 pounds of fiber, or 12 American bales, was produced in the experimental fields at Yuma and Sacaton.

The best yield obtained at Yuma was at the rate of 2,158 pounds of seed cotton or 604 pounds of lint^a per acre, i. e., about 1½ American bales, as compared with practically 2 American bales from the best-yielding plot in 1907. The difference is partly due to two severe wind-storms, which blew much of the ripe cotton out of the bolls,

^a Estimated on a basis of 28 per cent of lint, which was the actual percentage for the entire crop at Sacaton. The actual yield in the above case was 453 pounds of seed cotton from one-fifth of an acre.

causing an estimated loss of from 25 to 35 per cent of the total crop. It is probable that the yields also suffered from the less favorable autumn temperatures of 1908, the month of October especially having been notably cooler than in 1907. In 1908 the earliest killing frost occurred in the Yuma Valley November 25, while in 1907 a killing frost was not experienced until December 19.^a Inability to obtain water for irrigation at critical periods in the growth of the plants likewise affected the yields adversely.

The total yield from the 19½ acres grown at Sacaton was 5,000 pounds, or 10 American bales; hence, an average of slightly more than one-half bale per acre. This yield was unexpectedly low, but a variety of causes combined to produce the result. The chief of these were: (1) A heavy rain just after one of the fields was planted and the presence of the root-rot fungus and of root lice, which injured the stand to some extent. (2) Insufficient moisture in the soil, some parts of the fields having been kept too dry throughout the summer. (3) A wind and rain storm on September 8, which caused much of the ripe cotton to be lost. (4) An unusually early killing frost, most of the leaves on the cotton plants having been killed on October 21, when the temperature fell to 28° F.^b At least one-half of the crop was lost as a result of these various circumstances.

Of the total amount of fiber produced at Sacaton, 45.6 per cent was obtained in the first picking, 35.7 per cent in the second, and 18.7 per cent in the third. Since nearly half of the total crop was harvested at the first picking, while on the different plots at Yuma in 1907 only from 17.5 to 32 per cent of the total yield was obtained

^a For further comparison of the temperature at Yuma in the autumns of 1907 and 1908 it may be noted that the absolute minima at the main Weather Bureau station at Yuma, which is situated on considerably higher land than where the cotton was grown, were as follows:

1907.		1908.	
October	(on the 29th), 53° F.	October	(on the 19th), 38° F.
November	(on the 21st), 34° F.	November	(on the 29th), 30° F.
December	(on the 19th), 34° F.	December	(on the 21st), 34° F.

At the substation in the Yuma Valley, where the conditions are similar to those on the experimental cotton farm, the absolute minimum for October, 1908, was 30° F. on the 29th, and for November it was 24° F. on the 29th.

The monthly mean temperatures at the main station were as follows:

1907.		1908.	
September	82.2° F.	September	82.6° F.
October	72.7° F.	October	68.3° F.
November	62.6° F.	November	62.3° F.
December	56.4° F.	December	53.1° F.

^b The minimum temperature on the same night at Phoenix was 41° F., while the absolute minimum recorded for the month of October at Phoenix is 36° F.

at the first picking, it is clear that the later ripening portion of the crop at Sacaton was far below what it should have been in a normal season.

The average percentages of lint in the seed cotton at Sacaton were as follows for the several pickings: First picking, 28.2; second picking, 29.4; third picking, 26.5. The average for the entire crop was 28 per cent.

QUALITY OF THE FIBER.

Six grades were distinguished by Mr. John A. Walker in classifying the fiber produced at Yuma and Sacaton in 1908, as follows:

1. Staple $1\frac{1}{16}$ to $1\frac{1}{8}$ inches, "extra fine," silky.
2. Staple $1\frac{7}{16}$ to $1\frac{1}{2}$ inches.
3. Staple $1\frac{5}{8}$ inches.
4. Staple $1\frac{1}{4}$ to $1\frac{3}{8}$ inches.
5. Staple $1\frac{1}{8}$ to $1\frac{1}{4}$ inches.
6. Staple $1\frac{1}{4}$ to $1\frac{3}{8}$ inches, dirty.

The percentages of the total product at the two localities represented by each grade are as follows:

	1.	2.	3.	4.	5.	6.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Yuma	9.8	9.3	38.6	15.2		7.1
Sacaton			36.0	60.0	2.7	.5

The fact that the two highest grades, which were almost wanting at Sacaton, are comparatively well represented at Yuma is attributable chiefly to the fact that most of the fiber included in these grades was picked from the best rows in the plant-breeding nursery, which was located at Yuma. This cotton was, of course, the most highly selected of all that was grown in 1908. The best fiber at Sacaton was obtained at the third picking of the plants selected here and there in the fields to furnish seed for the 1909 planting.

On the whole the 1908 fiber was somewhat inferior in length to that produced at Yuma in 1907. There was, however, evidence of a general tendency to a shortening of the length of cotton fiber in Upland as well as in Egyptian varieties in the Colorado River region in 1908. Such a result during a single season should not cause discouragement unless the tendency is found to persist. In Egypt it has been noticed that in occasional years the fiber produced in large districts and even throughout the cotton-growing area is decidedly inferior in length and other qualities, and the causes of this inferiority are by no means always obvious.

While a length of $1\frac{3}{8}$ inches in imported Mit Affi cotton is regarded as satisfactory, it is believed to be desirable to produce a longer staple in the Southwest. That there is reasonable hope of accomplishing this may be inferred from the fact that on the 110 provisional selections of individual plants made in the breeding nursery at Yuma the average length of staple was $1\frac{1}{2}$ inches.

As regards other qualities, the strength and fineness were generally satisfactory. The color was in the main somewhat lighter than in 1907. Luster was generally deficient. It was observed that the fiber in newly opened bolls is satisfactory in this respect, but the gloss soon disappears, probably because of exposure to the extremely dry air of the region. The gradual deterioration in the silky feeling of the fiber is probably due to the same cause. It may therefore be found desirable to pick the cotton as soon as possible after the bolls open. This will largely depend upon whether the price is sufficiently enhanced to warrant the increased expense of the more numerous pickings.^a It would doubtless aid in preserving the luster and silkiness of the fiber to store it both before and after ginning in as cool a room as can be had and, if precautions are used, to moisten artificially the atmosphere of the storeroom.

Both at Yuma and Sacaton the fiber from the third picking was invariably superior in length and fineness and generally in strength to that from the first and second pickings. As a rule, the second picking yielded better fiber than the first.^b This is probably due, at least in part, to the fact that the bolls of the first crop open throughout September and much of the ripe cotton remains exposed for a considerable period to the very dry, hot air of that month. The fourth picking at Yuma (made December 18-23) yielded very long and silky but weak and wasty fiber. This was probably furnished in great part by unripe frost-opened bolls.

PLANT-BREEDING WORK.

At Yuma the work of selection in the breeding nursery, which was planted with seed from the very best plants selected in 1907, was continued as in previous years. The object of this work is of course to increase the productivity and the length, strength, fineness, and other qualities of the lint, so that if the industry becomes established

^aA further advantage of frequent picking would be the greater cleanness of the fiber, since dust would have less opportunity to accumulate in it and there would be less trash, the valves of the bolls and the involucrel bracts being less dry and brittle when the picking is done. Moreover, there would be a smaller loss of seed cotton from the open bolls on account of windstorms.

^bAt Sacaton all of the first general picking was placed by Mr. Walker in his fourth grade, while part of the second and all of the third went into his third grade.

in the Southwest superior seed, capable of producing a grade of fiber that will command the highest prices paid for this type of cotton, will be available.

Two rows in the nursery, each grown from a single selected plant of 1907, showed decided superiority over all the others, both in the number of exceptionally fine individual plants (seeds of each of which were saved separately for planting in the breeding nursery in 1909) and in the high quality of the bulked fiber from the remaining (unselected) plants. One of these rows represents the Mit Afifi type, having fine, crinkly fiber of a pronounced brown color. The other has long, silky, almost white fiber and approaches more nearly the Abbasi type. Plantings of the bulk seed from several of the best rows will be made this spring, and seed from the progeny of those rows which most successfully maintain their high quality will be increased as rapidly as possible with a view to future distribution to farmers.

In all, 110 provisional selections of individual plants were made at Yuma in 1908, the best of which will be retained for planting the breeding nursery in 1909. The preference will be given to plants from rows having a high "projected efficiency," i. e., in which the highest percentage of good plants occurred. The average length of fiber for the 110 selections was $1\frac{1}{2}$ inches. A length of $1\frac{3}{4}$ inches in imported Mit Afifi cotton is considered very satisfactory.

Since the cotton showed considerable variation at Sacaton as compared with that grown from the same stock of seed at Yuma, it was considered desirable to make numerous selections of the best individual plants at Sacaton also, the seed from which will be planted there in a nursery this season on the "plant-to-row" system with a view to obtaining an improved strain or strains better adapted to the local conditions in that part of the Gila Valley. In addition to these, seed from several hundred plants that were above the average in yield and quality of lint was mixed together for the general planting in 1909.

To keep this high-bred cotton up to standard it will be necessary to practice continuous selection of seed. Intensive breeding by careful selection of the very best individual plants will probably have to be carried on either by governmental institutions or by a few of the best farmers in each locality who make a specialty of the production of superior seed. But every farmer can practice selection to a certain extent, and by doing so can probably avoid going off his own farm for seed for several years at a time. All that is necessary is to go through the field before the first picking and mark with rags or in some other way the most productive plants having a good quality of fiber. These can then be picked and ginned separately and the seed kept apart from the general crop for next year's planting.

PLANTING DISTANCE.

Experiments were made at Yuma to determine the effect upon the yield and quality of the fiber of different planting distances. The distances tested were: (1) The usual Egyptian distance, $2\frac{1}{2}$ feet between the rows and 16 inches between the hills; (2) $4\frac{1}{2}$ feet between the rows and 2 feet between the hills; (3) 5 feet between the rows and $2\frac{1}{2}$ feet between the hills; (4) 6 feet between the rows and 3 feet between the hills, the last distance being that followed in all the other plantings at Yuma. Owing to variation in the soil moisture in the different plots, due to imperfect leveling, differences of texture, and the accidental escape of irrigating water in some cases, no satisfactory conclusions could be drawn from these experiments. Some plots or portions of plots were too wet and others too dry during much of the summer to permit of a fair comparison. Apparently the yields were as heavy where the wider planting distances were used as where the rows and hills were closest together.

IRRIGATION METHODS.

Further experimenting is necessary before any definite recommendations can be made as to how to manage the irrigation of Egyptian cotton on the different soils of the region. Experiments with furrow irrigation were made at Sacaton, and Mr. E. W. Hudson reports that the results were satisfactory. His method consisted of "plowing a furrow on each side of each row and allowing the water to run through until the ground between the furrows was saturated." Mr. Hudson further states: "This appears to be a great improvement over flooding, because the entire surface does not cement together."

PRODUCTIVENESS IN RELATION TO TIME OF PLANTING AND RATE OF IRRIGATION.

The way in which Egyptian cotton plants develop is largely influenced by the time of planting and by the amount of irrigation they receive. Mr. O. F. Cook points out that the effect of external conditions upon the yield is increased by the fact that the cotton plant has two distinct kinds of branches. The fertility of the plant depends in great measure upon the early development of the special fruiting branches.

Experiments were made at Yuma to determine the effect of planting at different dates during the spring. The result showed clearly that planting as early as the weather permits gives the best results. Some farmers planted Egyptian cotton in the Colorado River region in 1908 as late as April 20 to June 1. Without exception these late-planted fields produced a crop of bolls on the upper part of the plants

only, giving probably not more than one-third to one-half of the yield that would have been obtained had planting been done at the right time. When the seed is put in so late that practically the entire development of the plants takes place during the hottest part of the summer there is a rapid, weedy growth of the main stem and of the large sterile branches. This sometimes prevents the formation of the fruiting branches on the lower part of the plant. In other cases, although such branches are formed, they are short and weak and may die and drop off before the bolls ripen. Hence no "bottom crop" is obtained.

The results obtained in 1908 make it evident that Egyptian cotton plants are extremely sensitive to fluctuations in soil moisture and that the yield and quality of the fiber depend largely upon the way irrigation is managed. Excessive application of water in the early stages of growth, especially if the cotton has been planted late, causes the plants to shoot up into a tall, spindling, unfruitful form. A sparing use of water during the first period of development induces a better growth of these lower fruiting branches. But there is danger that if the economy of water is carried too far the plants may become too much dwarfed in growth, setting only a few small bolls, which often open prematurely and produce short, weak, coarse fiber.

During the hottest part of the summer, when the cotton is in blossom and the bolls are setting, a too sparing use of water checks the growth of the whole plant and particularly causes injury by hindering the development of bolls on the upper part of the plant.

The soil should certainly not be allowed to get so dry that the wilting which normally takes place during the hottest part of the day becomes conspicuous and the plants are slow to recover their fresh appearance as evening approaches. The productiveness of the plants is sure to be injured by a cessation of development due to lack of moisture in the soil, followed by the sudden stimulus to growth caused by a heavy irrigation. A steady, even development of the plant, especially after the bolls begin to form, is the ideal to be kept in view.

CROSSING WITH OTHER VARIETIES.

The lack of uniformity in the cotton plants and fiber manifested in 1908 was further accentuated by the presence of numerous hybrids with Upland varieties. In 1906 and 1907 several plots of Upland cottons were grown alongside the experimental field of Egyptian cotton at Yuma in order to test their productiveness and general adaptability to the region in close comparison with the latter. The belief was generally current at that time among cotton breeders that the percentage of hybrids produced under these conditions would be

too small to be of practical importance. It has been found, however, that the conditions at Yuma are exceptionally favorable to the carrying of pollen from one plant to another, the cotton flowers being visited by several species of bumblebees and other Hymenoptera in large numbers. As a result, in 1907 and again in 1908 numerous hybrids appeared among the Egyptian plants.

The elimination of this hybrid element from the acclimatized Egyptian stock is one of the most serious problems in connection with the experimental work. Fortunately some of the best selections appear to have largely escaped contamination and are behaving in a very uniform manner. These will be relied upon as the basis of pure strains. Otherwise, acclimatization of freshly imported seed must be resorted to, and with this possible contingency in view carefully isolated plantings of new seed of the leading Egyptian varieties will be made at Yuma this year.

The practical lesson to be drawn from the occurrence of these hybrids is that growing any other type, and especially Upland, in the proximity of commercial cultures of Egyptian cotton is bound to result in disaster to the latter. The presence of Upland varieties in the neighborhood will make it impossible to secure pure seed of Egyptian cotton. While the fiber of the first generation hybrids is often excellent, it differs from Egyptian cotton in length, color, and texture, and hence when mixed with the latter lowers the uniformity of the product. The commercial value of Egyptian cotton largely depends upon its uniformity, and this is one of the chief reasons why it is so highly prized by spinners. Furthermore, the fiber of hybrids of later generations is usually very inferior to that produced by first-generation plants.

DISEASES AND INSECT ENEMIES.

The only diseases that appeared in the Egyptian cotton in 1908 were a few small spots at Sacaton, due to the root-rot fungus (*Ozonium omnivorum*) and a mild attack of damping-off, caused by fungi of the genus *Rhizoctonium*, which appeared early in April on the seedlings at Yuma and Sacaton.

Root-rot is well known in irrigated districts in the Southwest as the disease which causes bare spots in alfalfa fields. As it also attacks cotton, badly infected alfalfa fields should not be planted to the latter crop. Most of the plants in the spots at Sacaton died late in the season, after they had made nearly their full growth and produced many bolls. Mr. Hudson states that the spots did not appear to increase in size during the period of growth of the cotton crop.

Deep fall plowing previous to planting cotton will probably greatly mitigate the severity of the attack of this fungus.¹

The damping-off fungus, which appeared before thinning had been done, caused comparatively little damage to the stand in either locality and did not seem to have affected the later growth of the plants. In some seasons, however, this disease may necessitate more or less replanting. Thorough plowing and perfect tilth, so as to secure good aeration of the soil, are recommended as a means of reducing the damage from damping-off.²

Mr. W. A. Orton points out that Egyptian cotton is particularly susceptible to the bacterial disease known as "black-arm," the presence of which in a locality would almost certainly prevent the establishment of this promising industry. It is therefore of the greatest importance that no cotton seed be brought into the Colorado River region unless it is positively known that the seed was grown in a locality entirely free from this disease and that there has been no opportunity for infection in transit. Fumigation or disinfection of the seed can not be relied upon to destroy the germ of this disease.

The only injurious insect noticed in 1908 was a green aphid, or plant louse, which appeared at Sacaton in June on the roots of many of the plants. A small percentage of the infested plants died, apparently as a direct result of the attacks of this insect.

The presence of the cotton-boll weevil would undoubtedly be extremely disastrous to Egyptian cotton culture, since the length of the season during which the bolls are formed on this type of cotton, and the shading of the ground, due to the large size of the plants, create peculiarly favorable conditions for the multiplication of this insect. The weevil has not yet appeared in the Colorado River region, but its introduction may take place at any time, since farmers are securing seed of Upland varieties in the heart of the region where this insect is prevalent. The State of California issued a quarantine order last spring, requiring all cotton seed brought into the State to be inspected and fumigated by the State horticultural commission or by the county commissioners of Imperial, San Diego, Riverside, San Bernardino, or Los Angeles counties, acting as their deputies. As yet, however, no

¹For a description of this disease and recommendations for controlling it see the papers by C. L. Shear and George F. Miles, published as Bulletin No. 102, part 5, Bureau of Plant Industry, entitled "The Control of Texas Root Rot of Cotton," 1907, and Circular 9, Bureau of Plant Industry, entitled "Texas Root Rot of Cotton: Field Experiments in 1907," 1908.

²W. L. Balls, in Yearbook of the Khedivial Agricultural Society (Egypt) for 1906, pp. 93 to 111, describes a treatment of the seed with sulphuric acid and gypsum before planting, which he has found efficacious in destroying the spores of the fungus.

quarantine law exists in Arizona, although last year the agricultural experiment station inspected and fumigated all cotton seed known to have been brought into the Territory.

ALKALI RESISTANCE.

In a portion of one of the fields at Sacaton there was so much alkali present in the soil as to prevent a stand being obtained. Examination of the soil around the scattered plants occurring there showed that a good growth, numerous bolls, and a fair quality of fiber can be produced by exceptionally resistant individuals in the presence of from one-half to 1 per cent of total salts in the first 3 feet of the soil. The preponderating salt was sodium chlorid, or common salt, but with considerable sodium sulphate and sodium bicarbonate present—the type of alkali that is most common in southern Arizona and southeastern California. This indicates a considerable tolerance for alkali on the part of the Egyptian cotton plant, since it is well known that saline soils in which sodium chlorid forms the greater part of the alkali are more injurious to most crop plants than the type in which sodium sulphate predominates. No plants grew at Sacaton in places where the average amount of alkali in the first 3 feet of soil was as high as 1.7 per cent.

While resistant individual plants can produce a small amount of fairly good fiber in the presence of from one-half to 1 per cent of alkali, it is probable that land containing considerably less than one-half of 1 per cent must be selected in order to obtain anything like a full stand and the best quality of fiber. The actual limit of safety remains to be determined.

Apparently Egyptian cotton is somewhat less resistant to alkali than the Upland varieties, although more information is needed on this point also.

Examination of the bulk fiber obtained from the portion of the field where alkali was present in noticeable quantity showed that the staple was decidedly shorter than elsewhere at Sacaton, running $1\frac{1}{8}$ to $1\frac{1}{4}$ inches in the first and second pickings and $1\frac{1}{4}$ to $1\frac{3}{8}$ inches in the third; hence, averaging nearly or quite one-eighth inch shorter than the fiber grown on soil containing no appreciable amount of alkali. There also seemed to be a tendency to a greater development of fuzz on the seeds of Egyptian cotton in alkali soil.

PRESENT OUTLOOK FOR EGYPTIAN COTTON IN THE SOUTHWESTERN STATES.

Region where the best results have been obtained.—Egyptian cotton requires a long season for maturing a full crop. The part of the United States where, from present indications, the greatest success

can be expected is the Colorado River region in southwestern Arizona and southeastern California, including the valleys of the Salt, Gila, and Colorado rivers and the Imperial Valley. It has been demonstrated that large yields of high-grade fiber can be produced under irrigation in that region. Extreme southern Texas, especially the lower Rio Grande Valley, is probably suited for Egyptian cotton so far as climate is concerned, but the presence of the boll weevil, to which this type of cotton falls an easier prey than any other, makes its successful culture there very doubtful under existing conditions.

Advantages over Upland cotton.—It is almost certain that if cotton growing can be made commercially successful in the extreme Southwest it must be on the basis of some superior long-staple type which commands a premium over Middling Upland. The average price paid for the Egyptian cotton imported in 1908 represents a premium of nearly 7 cents per pound. Under irrigation in this region, fully as large yields appear to be obtainable from Egyptian as from Upland varieties. The cost of the operations necessary to produce a crop, with the exception of harvesting, is not greater for Egyptian than for Upland cotton. The increased cost of picking, due to the small bolls and large size of the Egyptian plants, is much more than counterbalanced by the greater value of the product.

Exclusion of other cotton.—No other cotton should be grown in a locality where culture of the Egyptian type is to be undertaken. Experience has shown that in the Southwestern States Egyptian cotton crosses very readily with Upland varieties if grown anywhere in the neighborhood, and the result is a rapid deterioration of the Egyptian fiber, the product suffering in uniformity by reason of the different length and white color of that from the hybrid plants. Uniformity more than any other one quality determines the price paid for Egyptian cotton. Furthermore, intermixture with the large fuzzy seeds of the hybrids makes clean ginning difficult. Hence, any community of farmers desiring to undertake the growing of Egyptian cotton should see to it that no other type of cotton is planted in their vicinity.

Value of a local reputation.—It will prove an immense advantage to any locality producing this high-class fiber if buyers learn to identify the locality with the type produced, knowing that in a particular valley they can depend upon securing a certain good quality of Egyptian cotton and no other. The name of such a locality will ultimately become associated with the grade produced, as is now the case in Egypt, where cotton coming from certain provinces is given the preference by buyers, owing to the general high reputation of those particular districts.

Extensive planting at first should be avoided.—Public opinion should be educated in every possible way as to the undesirability of handling Egyptian cotton as a "bonanza" crop. In view of the scarcity and high price of labor in the Southwest, farmers should proceed very cautiously in planting cotton. A very small area will be sufficient to teach the would-be grower how the cotton behaves in his locality, how he must irrigate and cultivate it to secure a good yield and satisfactory quality of fiber, and what the prospects are for getting a larger acreage picked at reasonable cost. Problems of transportation and marketing still remain to be worked out. It is probable that even if all these problems are satisfactorily solved the individual farmer should avoid extensive plantings. A few acres on each farm, which the farmer's own family can care for and pick, if necessary, will be a much safer investment.

If Egyptian cotton finds a place among the agricultural industries of the Southwest, it will be as a money crop from which a sure but moderate profit may be expected. Its safety lies in its not being a perishable product which must be rushed to the market as soon as it is harvested, regardless of market conditions.

Community action essential.—In establishing Egyptian cotton culture in any locality cooperation among a number of growers will be essential. In order to market the product to advantage it will be necessary to produce a greater quantity having a uniform quality than any single farmer is likely to grow. Much more favorable terms can be secured from buyers if large numbers of bales of the same type and grade are sold together. Furthermore, a number of farmers by joining forces can purchase the machinery needed for ginning and baling the cotton, which it is out of the question for each individual farmer to do.

Necessity of excluding diseases and injurious insects.—Since the presence of either the cotton boll weevil or the bacterial disease known as "black-arm" would in all probability put a stop to any effort to grow Egyptian cotton, communities proposing to undertake its culture should take every precaution to prevent the introduction of these pests. The safest plan will be to exclude rigorously all seed obtained in localities whose freedom from both the weevil and the disease can not be definitely ascertained. Disinfection of the seed may keep out the weevil, but can not prevent the introduction of "black-arm."

SUMMARY.

During the year 1908, 61½ million pounds of Egyptian cotton were imported into the United States. The average price paid for this cotton on the Boston market in 1908 was 18.07 cents per pound, as

compared with 11.11 cents for Middling Upland. The total value of the direct importations from Egypt was more than \$11,560,000.

Spinning and weaving tests of the fiber produced at Yuma, Ariz., in 1907 were made by three American mills which use large quantities of imported Egyptian cotton. The consensus of the reports on these tests indicates that the acclimatized Mit Afifi grown in Arizona compares favorably with the better grades of this variety imported from Egypt.

In 1908 about 40 acres were planted to cotton of the Egyptian type in the Colorado River region in southern Arizona and southeastern California. Nearly half of this acreage was on the Pima Indian Reservation at Sacaton, Ariz.

Direct comparison of the behavior of Egyptian cotton from newly imported seed with that from seed grown for several years in the Southwest gave further evidence of the necessity for acclimatizing this type of cotton before good yields and a high quality of fiber can be secured.

Considerable diversity in the shape and productiveness of the plants, as well as in the quality of the fiber, was manifested in various localities in the Colorado River region where the cotton was grown in 1908, although the same general stock of seed was everywhere used. This indicates the need of local adjustment in different parts of the region.

The highest yield obtained in 1908 was at the rate of 1½ American bales per acre on a one-fifth-acre plot on the experiment farm at Yuma. At Sacaton the average yield for the 19 acres grown was slightly over one-half bale. Unfavorable weather conditions and a temporary shortage of water for irrigation are chiefly responsible for the low yields as compared with those obtained in 1907.

The fiber was graded by an expert as it came from the gins and care was taken in baling to have the contents of each bale as uniform as possible. An effort will be made to market the 12 bales obtained under such conditions as to give a fair idea of the probable commercial value of this cotton in the Colorado River region.

The fiber produced in 1908 was on the whole somewhat shorter than that grown in 1907, and the average color was somewhat lighter. The strength and fineness were generally satisfactory.

Experiments at Sacaton with furrow irrigation indicate that at least under some conditions this method may give better results than flooding.

The development of the branches which bear the bolls, and consequently the productiveness of the plants, was found to be largely influenced by the time of planting and the way in which irrigation is managed. Early planted cotton gave in all cases the best yields.

Between the times when the bolls have begun to form and the first crop ripens, water should never be withheld so long that the development of the plants is severely checked. A steady, even growth is the ideal to be kept in view.

In the Colorado River region Egyptian cotton hybridizes very readily with Upland varieties. The fiber borne by the hybrid plants, although usually of excellent quality, differs in length, color, and texture from that of the pure Egyptian plants and hence injures the uniformity of the product.

A good stand and good quality of Egyptian cotton can only be expected on land containing less than one-half of 1 per cent of alkali in the first 3 feet of the soil, although exceptionally resistant individual plants will produce a fair quality of fiber in the presence of one-half to 1 per cent.

Approved:

JAMES WILSON,

Secretary of Agriculture.

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